# Microgravity Viscosity Measurement Near the Liquid-Vapor Critical Point  (Invited)

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We used a novel, overdamped oscillator aboard the Space Shuttle to measure the viscosity $\eta$ of xenon near its critical density $\rho_c$ and temperature $T_c$. In microgravity, useful data were obtained within 0.1 mK of $T_c$, corresponding to a reduced temperature $t = (T-T_c)/T_c = 3 \times 10^{-7}$. Because they avoid the detrimental effects of gravity at temperatures two decades closer to $T_c$ than the best ground measurements, the data directly reveal the expected power-law behavior $\eta \propto t^{-vz_\eta}$. Here $v$ is the correlation length exponent, and our result for the viscosity exponent is $z_\eta = 0.0690 \pm 0.0006$. Our value for $z_\eta$ depends only weakly on the form of the viscosity crossover function, and it agrees with the value $0.067 \pm 0.002$ obtained from a recent two-loop perturbation expansion [H. Hao, R.A. Ferrell, and J.K. Bhattacharjee, preprint (1997)]. The measurements spanned the frequency range $2$ Hz $\leq f \leq 12$ Hz and revealed viscoelasticity when $t \leq 10^{-5}$, further from $T_c$ than predicted. The viscoelasticity's frequency dependence scales as $Af\tau$, where $\tau$ is the fluctuation-decay time. The fitted value of the viscoelastic time-scale parameter $A$ is $2.0 \pm 0.3$ times the result of a one-loop perturbation calculation.

Near $T_c$, the xenon's calculated time constant for thermal diffusion exceeded days. Nevertheless, the viscosity results were independent of the xenon's temperature history, indicating that the density was kept near $\rho_c$ by judicious choices of the temperature *vs.* time program. Deliberately injudicious choices led to large density inhomogeneities. At $t > 10^{-5}$, the xenon approached equilibrium much faster than expected, suggesting that convection driven by microgravity and by electric fields slowly stirred the sample.